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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/676,889	09/30/2003	Shih-Wei Liao	42P16806	8089
8791 7590 10/29/2007 BLAKELY SOKOLOFF TAYLOR & ZAFMAN 1279 OAKMEAD PARKWAY SUNNYVALE, CA 94085-4040			EXAMINER MITCHELL, JASON D	
			ART UNIT 2193	PAPER NUMBER
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

## Office Action Summary

Application No.

10/676,889

Applicant(s)

LIAO ET AL.

Examiner

Jason Mitchell

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 30 September 2003.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-30 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-30 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 30 September 2003 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
  - ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO/SB/08)
- Paper No(s)/Mail Date 12/22/03; 1/12/06.

4) ☐ Interview Summary (PTO 910)

Paper No(s)/Mail Date \_\_\_\_\_

5) ☐ Notice of Informal Patent Application

6) ☐ Other: \_\_\_\_\_

**DETAILED ACTION**

1. Claims 1-30 are pending in this application.

***Drawings***

2. **Figures 1 and 2 should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g).**
3. The figures show prior art systems usable with or by the claimed system, but do not show any structure representing an aspect of the claimed system (see. e.g. Fig. 3, Compiler 308). Accordingly the drawings only show that which was known at the time of filing.
4. Corrected drawings in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.
5. **The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference character(s) not mentioned in the description: Fig. 2, "Data \$" 242, Fig. 3, "Data" 342, Fig. 12 and "Live-in Resources" 1203.**

Corrected drawing sheets in compliance with 37 CFR 1.121(d), or amendment to the specification to add the reference character(s) in the description in compliance with 37 CFR 1.121(b) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

**6. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the following reference sign(s) mentioned in the description: "data 312" referenced in par. [0041].**

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of

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any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

***Specification***

7. The lengthy specification has not been checked to the extent necessary to determine the presence of all possible minor errors (e.g. par. [0035] "According to on embodiment" should read "According to one embodiment"). Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

***Claim Rejections - 35 USC § 101***

8. 35 U.S.C. 101 reads as follows:

Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

9. **Claims 8-14 and 23-28 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter.**

Claims 8 and 23 are not limited to statutory embodiments. In view of Applicant's disclosure, in par. [0028], the claimed medium is not limited to statutory embodiments, instead being defined as including both statutory embodiments (e.g., "read only memory ("ROM"); random access memory ("RAM"); magnetic disk storage media ...") and non-statutory embodiments (e.g., "Electrical, optical, acoustical or other form of propagated signals (e.g., carrier waves, infrared signals, digital signals, etc.)"). As such, the claim is not limited to statutory subject matter and is therefore non-statutory.

Claims 9-14 and 24-28 depend respectively from claims 8 and 23 and are rejected for the same reasons.

***Claim Rejections - 35 USC § 112***

10. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

11. **Claims 4 and 11 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.**

12. Claims 4 and 11 recite "the debug information" in lines 2-3 and 3-4 respectively. There is insufficient antecedent basis for this limitation in the claims.

***Claim Objections***

13. **Claim 30 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim.**

Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form.

Claim 30 recites the "helper threads are generated by a compiler". It is noted that claim 29 also recites the "helper thread being created during a compilation". Those of ordinary skill in the art would have recognized that a thread "created during a compilation" would also be "generated by a compiler". Thus claim 30 does not further limit its parent claim 29.

***Claim Rejections - 35 USC § 102***

14. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

15. **Claims 1-2, 8-9, 15-16-19, 22-25 and 28-30 are rejected under 35**

**U.S.C. 102(b) as being anticipated by “Tolerating Memory Latency through Software-Controlled Pre-Execution in Simultaneous Multithreading Processors” by Luk (Luk).**

16. **Regarding Claim 1:** Luk discloses a method, comprising:

identifying a region of a main thread that likely has one or more delinquent loads, the one or more delinquent loads representing loads which likely suffer cache misses during an execution of the main thread (pg. 44, col. 2 3<sup>rd</sup> full par. “locality analysis phase which determines which references are likely to cause cache misses”; also see Appendix Phase I, Step 1);

analyzing the region for one or more helper threads with respect to the main thread (pg. 44, col. 2 3<sup>rd</sup> full par. “locality analysis phase which determines which references ... could benefit from pre-execution”; also see the Appendix Phase I, Step 3); and

generating code for the one or more helper threads, the one or more helper threads being speculatively executed in parallel with the main thread to perform one or more tasks for the region of the main thread (pg. 44, col. 2, 3<sup>rd</sup> full par. "performs all necessary code transformations"; also see the Appendix Phase II).

17. **Regarding Claim 2:** The rejection of claim 1 is incorporated; further Luk discloses identifying the region comprises:

generating one or more profiles for cache misses of the region (pg. 43, the par. bridging the cols. "based on profiling information"; also see the Appendix, Phase I, Step 1 "This step can be accomplished through some low-overhead profiling tools"); and

analyzing the one or more profiles to identify one or more candidates for thread-based prefetch operations (pg. 43, the par. bridging the cols. "the compiler usually needs to heuristically decide how to prefetch ... based on profiling information").

18. **Regarding Claims 8-9:** Claims 8-9 recite a computer readable medium for instructing a computer to perform the methods of claims 1-2 and are addressed similarly.

19. **Regarding Claims 15-16:** Claims 15-16 recite a system for performing the method of claim 1 and are addressed similarly.



Additionally claim 16 recites and Luk discloses the process is executed by a compiler during a compilation of an application (pg. 44, col. 2, 3<sup>rd</sup> full par. "the compiler ... is responsible for inserting pre-execution").

20. **Regarding Claim 17:** Luk discloses a method, comprising:

executing a main thread of an application in a multi-threading system (pg. 40, col. 1, 2<sup>nd</sup> par. "single threads running on multithreaded processor"); and

spawning one or more helper threads from the main thread to perform one or more computations for the main thread when the main thread enters a region having one or more delinquent loads (pg. 40, col. 1, 2<sup>nd</sup> par. "spawning helper threads ... generates data addresses, on behalf of the main thread"), code of the one or more helper thread being created during a compilation of the main thread (pg. 44, col. 2, 3<sup>rd</sup> full par. "the compiler ... is responsible for inserting pre-execution").

21. **Regarding Claim 18:** The rejection of claim 17 is incorporated; further Luk discloses:

creating a thread pool to maintain a list of thread contexts (pg. 42, col. 1, 1<sup>st</sup> full par. "N hardware contexts supported by the machine"); and

allocating one or more thread contexts from the thread pool to generate the one or more helper threads (pg. 41, col. 1, the last partial par. "Each thread-spawning instruction requests for an idle hardware context to pre-execute the code sequence").

22. **Regarding Claim 19:** The rejection of claim 18 is incorporated; further Luk discloses:

terminating the one or more helper threads when the main thread exits the region (pg. 46, col. 1, 3<sup>rd</sup> par. "terminate a pre-execution thread if ... the main thread has executed N instructions after passing P"); and

releasing the thread contexts associated with the one or more helper threads back to the thread pool (pg. 41, col. 2, the 1<sup>st</sup> partial par. "T will free its hardware context").

23. **Regarding Claim 22:** The rejection of claim 17 is incorporated; further Luk discloses discarding results generated by the one or more helper threads when the main thread exits the region, the results not being reused by another region of the main thread (pg. 41, col. 2, the 1<sup>st</sup> partial par. "results held in T's registers are simply discarded").

24. **Regarding Claims 23-25 and 28:** Claims 23-25 and 28 recite a computer readable medium for instructing a computer to perform the methods of claims 17-19 and 22 and are addressed similarly.

25. **Regarding Claims 29-30:** Claims 29-30 recite a system for performing the method of claim 17 and are addressed similarly.

***Claim Rejections - 35 USC § 103***

26. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

27. **Claims 3-4 and 10-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over “Tolerating Memory Latency through Software-Controlled Pre-Execution in Simultaneous Multithreading Processors” by Luk (Luk) in view of “Exploiting Hardware Performance Counters with Flow and Context Sensitive Profiling” by Ammons et al. (Ammons).**

28. **Regarding Claim 3:** The rejection of claim 2 is incorporated; further Luk discloses generating one or more profiles for an application (pg. 43, the par. bridging the cols. “decide how to prefetch ... based on profiling information”) but does not explicitly disclose executing the application with debug information or sampling cache misses and accumulating hardware counters for each static load.

29. Ammons teaches generating one or more profiles comprises:  
executing an application associated with the main thread with debug information (pg. 86, col. 1, last full par. “a tool ... that instruments program executables”); and

sampling cache misses and accumulating hardware counter for each static load of the region to generate the one or more profiles for each cache hierarchy (pg. 85 col. 2 1<sup>st</sup> full par. "exploits the hardware performance counters").

30. It would have been obvious to one of ordinary skill in the art at the time the invention was made to implement Luk's profiling (pg. 43, the par. bridging the cols. "based on profiling information") using Ammons methods (pg. 86, col. 1, last full par.; pg. 85 col. 2 1<sup>st</sup> full par.) to achieve the improved profiling disclosed (Ammons pg. 85, col. 2, 1<sup>st</sup> full par. "extends profiling techniques in two new directions").

31. **Regarding Claim 4:** The rejection of claim 2 is incorporated; further Luk discloses analyzing the one or more profiles comprises:

correlating the one or more profiles with respective source code based on the debug information (pg. 41, col. 1, the last partial par. "decide where to launch pre-execution in the program, based on ... cache miss profiling").

32. Luk does not disclose identifying top loads that contribute to cache misses.

33. Ammons teaches identifying top loads that contribute cache misses above a predetermined level as the delinquent loads (pg. 86, col. 2, 1<sup>st</sup> partial par. "1% of the paths ... account for 42 and 56% of the misses.").

34. It would have been obvious to one of ordinary skill in the art at the time the invention was made to identify the top loads discussed in Ammons (pg. 86, col. .2, 1<sup>st</sup> partial par.) in Luk's profile data (pg. 43, the par. bridging the cols. "based on profiling information") in order to balance the number of helper threads that are created with the effectiveness of each thread.

35. **Regarding Claims 10-11:** Claims 10-11 recite a computer readable medium for instructing a computer to perform the methods of claims 3-4 and are addressed similarly.

36. **Claims 5-7 and 12-14 are rejected under 35 U.S.C. 103(a) as being unpatentable over "Tolerating Memory Latency through Software-Controlled Pre-Execution in Simultaneous Multithreading Processors" by Luk (Luk) in view of "Data Prefetching by Dependence Graph Precomputation" by Annavaram et al. (Annavaram).**

37. **Regarding Claim 5:** The rejection of claim 1 is incorporated; further Luk does not disclose building a dependent graph and performing slicing based on the dependent graph. Luk does disclose "a collection of schemes ... have been proposed to construct and pre-execute slices" (pg. 50, col. 1, the last partial par.)

38. Annavaram teaches building a dependent graph that captures data and control dependencies of the main thread (pg. 1 Abstract “efficiently generates the required dependence graphs”); and

performing a slicing operation on the main thread based on the dependent graph to generate the helper threads (pg. 1 Abstract “generate the data addresses of the marked load/store instructions”).

39. It would have been obvious to one of ordinary skill in the art at the time the invention was made to integrate Anavaram’s dependent graph and associated slicing operation with Luk’s system because “[Luk’s] approach and [Anavaram’s] can be complementary” (see Luk pg. 50, col. 2, 1<sup>st</sup> partial par.)

40. **Regarding Claim 6:** The rejection of claim 5 is incorporated; further Luk discloses analyzing the region further comprises:

performing a scheduling between the main thread and the helper threads (pg. 44, col. 2, 3<sup>rd</sup> full par. “a scheduling phase”); and

determining a communication scheme between the main thread and the helper threads (pg. 44, Fig. 4 “Proposed instruction set extensions to support pre-execution”).

41. **Regarding Claim 7:** The rejection of claim 6 is incorporated; further Luk discloses analyzing the region further comprises determining a synchronization period for the helper threads to synchronize the main thread and the helper threads, each of

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the helper threads performing its tasks within the synchronization period (pg. 46, col. 1, 2<sup>nd</sup> par. a pre-execution thread must be terminated if its next PC is out of the acceptable range”).

42. **Regarding Claims 12-14:** Claims 12-14 recite a computer readable medium for instructing a computer to perform the methods of claims 5-7 and are addressed similarly.

43. **Claims 20-21 and 26-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over “Tolerating Memory Latency through Software-Controlled Pre-Execution in Simultaneous Multithreading Processors” by Luk (Luk) in view of US 7,243,267 to Klemm et al. (Klemm).**

44. **Regarding Claim 20:** The rejection of claim 17 is incorporated; further Luk discloses determining a period for each of the helper threads, each of the helper threads being terminated when the respective period expires (pg. 46, col. 1, 2<sup>nd</sup> par. “Once this limit is reached, the thread will be terminated anyway”).

45. Luk does not explicitly disclose the period is a time period.

46. Klemm teaches determining a time period for a thread (col. 5, lines 57-58 “thread execution time exceeds user-specified threshold”).

47. It would have been obvious to one of ordinary skill in the art at the time the invention was made to terminate one of Luk's helper threads after a time period expires (Klemm col. 5, lines 57-58 "thread execution time exceeds user-specified threshold") as an alternate or additional instance of Luk's "system-enforced terminating conditions for preserving correctness or avoiding wasteful computation" (col. 46, col. 1, 1<sup>st</sup> par.)

48. **Regarding Claim 21:** The rejection of claim 20 is incorporated; further Luk discloses each of the helper threads terminates when the period expires even if the respective helper thread has not been accessed by the main thread (pg. 46, col. 1, 2<sup>nd</sup> par. "the thread will be terminated anyway").

49. **Regarding Claims 26-27:** Claims 26-27 recite a computer readable medium for instructing a computer to perform the methods of claims 20-21 and are addressed similarly.

### ***Conclusion***

50. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jason Mitchell whose telephone number is (571) 272-




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3728. The examiner can normally be reached on Monday-Thursday and alternate Fridays 7:30-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Meng-Ai An can be reached on (571) 272-3756. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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